

#13

REPORT ON

FLOW TEST

OF

I.I.D. WELL NO. 1

BRAWLEY, CALIFORNIA AREA

**Donated By:
Herbert Rogers Jr.
Rogers Engineering Co.**

Prepared For

**O'NEILL GEOTHERMAL, INC.
410 West Ohio Street
Midland, Texas**

Prepared By

**ROGERS ENGINEERING CO., INC.
16 Beale Street
San Francisco, California**

June 1962

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1786-1A

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REPORT ON
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I.I.D. WELL NO. 1

1.0 SCOPE

The scope of this report is as follows:

- 1.1 Presentation of data obtained from the well flow metering tests performed during the week of May 28, 1962.
- 1.2 Interpretation of the observed data relative to total mass flow, chemical composition, and heat energy available from the well discharge at this stage in the well flow test program.
- 1.3 Compilation of well head pressure and temperature readings and other available pertinent data regularly logged from start of flow test program on May 18, 1962.
- 1.4 Determination of electric power generating capability of the well based on observed data.
- 1.5 Determination of quantity of major chemical constituents available from the well effluent.
- 1.6 Conclusions and recommendations regarding well performance, future test procedures, and test equipment.

2.0 TEST METHODS

The test method employed for measurement of well effluent comprises a two-phase flow measuring technique utilizing a pressure vessel which receives the total well effluent and discharges flashed steam and liquid through separate metered pipelines discharging to atmosphere.

Sampling connections provide for withdrawal of steam, gas, and liquids from various points in the testing system. Chemical analyses of the samples taken were made by a local chemical testing laboratory.

Pressure measurements in steam and liquid lines, well head, and separator were obtained from calibrated test gages.

Temperatures were obtained from glass tube mercury thermometers in thermowells provided in the piping and equipment.

Pressure drops across metering orifices in steam and liquid lines was obtained by U-tube mercury manometers.

Water level in the separator was observed in sight glasses attached to the side of the separator vessel and was controlled manually by adjusting a gate valve on the liquid discharge line of the vessel.

Pressure in the separator vessel was controlled by manual adjustment of a gate valve in the steam discharge line from the separator.

Well head pressure was increased (beyond the limitation imposed by separator operation) by throttling an 8-inch gate valve in the supply line from the well head to the separator.

Readings were taken only when the test system indicated stable conditions had obtained for each valve setting.

3.0 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

3.1 CONCLUSIONS

Analysis of the flow test results lead to the following conclusions:

- 3.11 Additional flow tests should be performed to provide flow data continuity for more accurate determination of maximum well flow capability.
- 3.12 A maximum total mass flow of 630,000 lbs./hr. was obtained at well head pressure of 220 psig and temperature of 415°F. This represents a flow increase of approximately 12½% since last perforations were made in the well casing.
- 3.13 The maximum steam flow obtained was 125,000 lbs./hr. at meter line pressure of 73 psig and temperature of 330°F., approximately 11°F. of superheat. Average superheat of the steam during the test run was approximately 12°F.
- 3.14 Installation of a 6" I.D. metering orifice in the liquid discharge line of the separator will provide more accurate data for determination of liquid flow.
- 3.15 A change in test procedure to provide a constant pressure of 200 psig at the separator, when throttling on the well head, should be initiated in order to determine if an increase in total flow will be indicated.

- 3.16 Salt precipitate build up in the liquid line metering and sampling connections and leads presents problems in obtaining accurate readings and representative samples and causes interruptions in test runs. Flushing water connections at these points would provide a ready means for clearing the lines and minimizing down time
- 3.17 Gross electrical generating capability available from the measured flow based on a double flash steam system is approximately 10,600-kw.
- 3.18 The chemical composition of the well effluent as shown in the chemical analyses is erratic. Some consistency is indicated in the last two analyses made and based on these analysis, the chemical production capability of the major chemical constituents is as follows:

NaCl - 128,000 lbs./hr. or 1,540 tons/day

KCl - 31,200 lbs./hr. or 370 tons/day

CaCl₂ - 63,500 lbs./hr. or 760 tons/day

3.2 RECOMMENDATIONS

Based on the above conclusions it is recommended that:

- 3.21 Two additional meter flow tests be performed - one approximately mid-July and the other just prior to well shut down.
- 3.22 A 6" I.D. metering orifice be installed in the liquid line metering run to replace the existing 7-1/2" I.D. orifice.
- 3.23 Test procedure be modified as follows: Bring separator pressure up to 200 psi in accordance with the visual test procedure. Hold separator pressure at 200 psi and throttle inlet to separator to maximum well head pressure permitted by valves in well head piping system.
- 3.24 Flushing water lines be connected to flushing connections provided at metering and sampling points.
- 3.25 Chemical analyses of the well effluent be obtained on at least a weekly basis for the remainder of the flow test program.
- 3.26 Samples be taken from the liquid line metering run for determination of specific gravity and chemical analyses at metering conditions using a multiple bottle technique. The sample bottles to be of a type similar to the existing bomb type bottle with

valves attached on inlet and outlet of each bottle to facilitate rapid installation and removal in the sampling run. Liquid sample to be weighed immediately upon removal from the line. Liquid may then be transferred to normal sample bottle for chemical analysis by the laboratory.

- 3.27 Sampling tubing size be increased to minimize possibility of salt blocks.
- 3.28 The specific heat, at 70°F., 150°F. and at 200°F., of representative samples of well effluent from well head and from the liquid metering run be obtained as a part of the sample analysis.
- 3.29 A feasibility report be prepared, based on final results of the test program to determine the size, type and cost of an electric power generating plant designed to utilize the maximum energy available from the well within practical and economic limits. The report would necessarily include analyses and recommendations for utilization or disposal of the chemical constituents of well effluent.

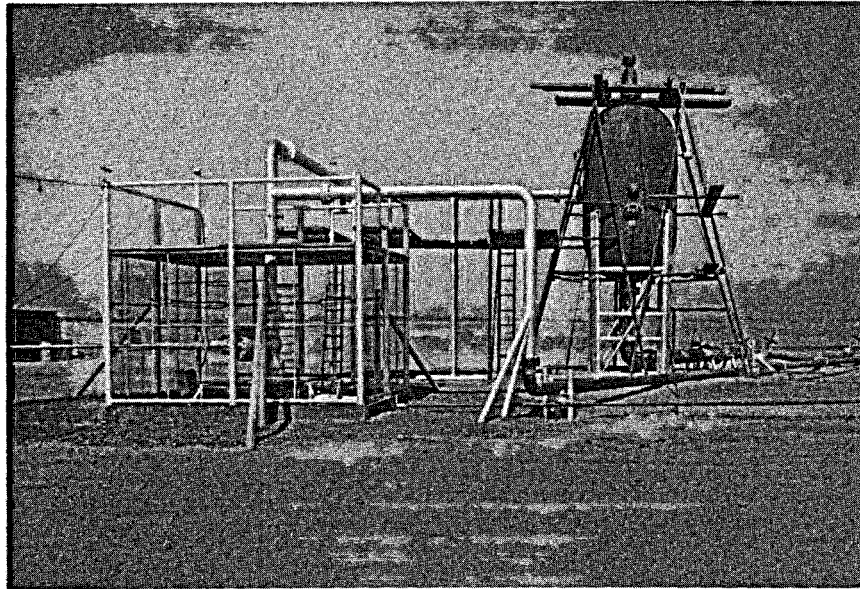


FIG. 1 - GENERAL ARRANGEMENT OF TEST EQUIPMENT

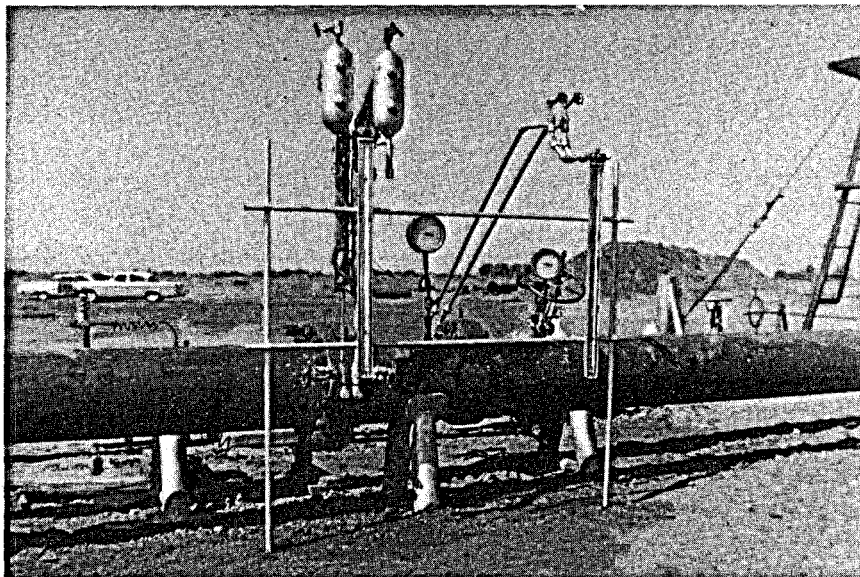


FIG. 2 - FLOW METERING STATION

4. DISCUSSION

4.1 Background

I.D. Well No. 1 is drilled to a depth of 5232' fully cased with a 7-5/8" O.D. casing. The casing is perforated with four 1/2" dia. holes per foot between depths 5212' to 5168'; 5140' to 5040'; and 5030' to 4900'.

The first metered flow test on I.I.D. Well No. 1 was performed on March 8, 1962 for a period of approximately 20 hours of well flow. During this period of flow, the well discharge was observed to be increasing but was yielding considerable drilling mud carry-over. In accordance with the recommendations resulting from this flow test, additional perforations were made in the well casing.

Permission to conduct a continuous well flow test program for a period of 90 days was obtained from The Colorado River Basin Regional Water Pollution Control Board providing for the determination of well flow characteristics and potential based on observations taken over that extended period of time.

The discharge of the separator by-pass (the blow line) was submerged in a newly excavated quench pool discharging into the Old Alamo River channel, and minor piping alterations were accomplished for future formal metered flow tests.

4.2 Description of Test

The test described in this report is the first metered test of I.I.D. Well No. 1 since the last perforations were made in the well casing subsequent to the flow test of March 8, 1962.

The well was put in flow condition on May 18, 1962 and was blown continuously from that date to the period of the test with only momentary interruptions for installation and adjustment of the test equipment. The general arrangement of the test equipment is shown on Drawings 1786-1A-1 and 1786-1A-2 in the appendix.

In order to obtain brine flow as accurately as possible, the water level in the separator was maintained in the midrange of the upper water glass on the vessel to preclude flashing in the liquid line at the orifice.

Well head pressure was controlled in two ways:

- (1) Throttling of steam discharge from the separator. This method was used for points 1 thru 7A.

- (2) Throttling of well discharge on entry line to the separator. This method was used for points 8 thru 13.

Well head pressures obtainable by method (1) are limited by the allowable operating pressure of the separator vessel (ASME rated 200 psi). Pressures obtainable by method (2) are limited by the rating of the throttling valve.

Point readings were taken only after stable conditions were reached subsequent to a change in valve setting.

The major difficulties encountered during the metering tests were attributable to precipitation of salts in the liquid line whenever pressure drop in the line or connected piping was sufficient to cause flashing. This condition became apparent in the following instances:

- (1) The pressure gage installed at the end of the liquid line to indicate critical lip pressure was ineffective throughout the test program due to salt deposited over the small detecting hole at the end of the line.
- (2) Development of a salt plug in the leads to the manometer metering the liquid line occurred on two occasions during the test program.
- (3) Development of a salt plugs in the leads to the specific gravity measurement station at the liquid line orifice meter precluded obtaining this data in the manner planned.
- (4) Extreme difficulty was experienced in obtaining samples for chemical analysis from the liquid line.
- (5) Loss of dilution water (normally injected into the liquid line downstream from the metering orifice to keep the line free of salt) caused an interruption of the metering test program on one occasion due to a salt pile build up at the end of the liquid line. The flow test was resumed only after dilution water was restored, the line flushed, and salt pile dissolved.

4.3 Test Results

4.31 General

The performance of the well under the varying conditions imposed during the test program indicates the well flow is approaching a stable condition, and data taken is considered to be reasonably reliable.

A plot of well head pressures and temperatures taken daily since May 18th is shown on Curve No. 3 in the Appendix. An increase in temperature and

pressure can be expected under continuous flow to a point at which stable flow is attained by the well. However, salt build-up in the blow line is a contributing factor to this increase.

The break in the temperature curve between May 24 and May 28 is caused by failure of the bi-metallic thermometer. This thermometer was replaced by a mercury thermometer.

The break in both the temperature and pressure curves on 13 June was caused by well shut down for replacement of the salted-up blow line with new clean line.

4.32 Well Flow

Field observations of meter readings for steam and liquid lines at various valve settings are shown in Table 1 in the Appendix. A summary of corresponding flow rates is shown in Table 2. Curve No. 1 shows the plot of the liquid and steam flows and the resulting total mass flow from the well plotted against well head pressure. From the curve maximum total mass flow was found to be 630,000 lbs/hr. with well head pressure at 220 psig and temperature 415°F.

Maximum steam flow is approximately 125,000 lbs/hr at well head pressure of 151 psig. Metering line pressure of 73 psig and temperature of 330°F indicate superheat of approximately 11°F.

The flow rates corresponding to the observed manometer readings were obtained by chart solution of applicable orifice meter flow equations for the metered fluid. Specific gravity used in liquid line flow calculations was obtained by extrapolation of published data on temperature effect on specific gravity for various saline solutions. The specific gravity of a sample taken from the liquid line metering run during the flow test was found to be 1.324 at ambient conditions. Extrapolating from this point to a temperature of approximately 390°F (average metering conditions) indicates that a specific gravity of 1.2 is a reasonable value to assign to the liquid at the orifice.

The flow curves plotted represent an average of the field data points. Decrease in total mass flow on the low pressure side of the maximum total mass flow curve represents the limitation imposed on the well flow by the configuration of the test system.

The lowest well head pressure observed under metering conditions (151 psig) reflects the limitation imposed on the well head by the test equipment and piping. No lower pressure is possible without changing the test system.

Analysis of the curves and data suggest that some modifications in test procedure will be required to provide additional continuity in data points and permit a more accurate determination of well flow characteristics.

To this end, it is recommended that the separator be brought to its maximum operating pressure as in the normal test procedure by throttling the steam discharge line from the separator. When maximum allowable separator pressure has been attained with the attendant increase in well head pressure, further increase in well head pressure should be obtained by throttling on the well head side (inlet) of the separator. It is possible that data obtained using this procedure will indicate a higher well flow capability than that indicated by this test.

It is further recommended that the existing 7-1/2" I. D. orifice in the liquid line be replaced with a 6" I. D. orifice. This will provide a larger differential reading at the manometer and result in a more accurate determination of flow.

4.33 Electrical Generation

The gross electrical generating capability of the well based on the results of this flow test is approximately 10,600 kw. This capability considers the optimum utilization of energy available through a two flash steam system supplying a conventional double entry steam turbine at 75% turbine-generator efficiency, and a condenser temperature of 100°F.

The determination of this capability was made on the basis of the maximum total mass flow of the well, the corresponding pressures and temperatures observed, and the specific heat of the well effluent. This capability is considered to be indicative only pending the results of further tests to determine continuity after free blowing of the well over the full test period.

The above generating system has been considered on the basis that it would be within practical economic limits for the observed well flow characteristics. A detailed engineering study and cost analysis based on the final results of the flow test program will be required in order to determine the optimum generating plant design for the well from a practical and economic standpoint.

4.34 Chemical Production

Analyses of the well effluent from samples taken at the well head are included in the Appendix of this report.

Examination of these analyses shows that quantitatively the chemical composition of the well effluent at the start of the flow test varied considerably

and erratically. (Samples S-20, S-22, and S-25)

The analyses of the samples taken during this flow test and the following week (S-29 and S-33) indicate a reasonable degree of consistency. It will be necessary, however, to continue chemical analyses of the well effluent on at least a weekly basis for the remainder of the flow test program to properly evaluate the trend or stability of the chemical characteristics of the well.

The quantitative analyses of the well effluent were performed on filtered samples for dissolved solids only, and therefore do not reflect the effect of the presence of undissolved solids in the effluent. Future analyses should include the undissolved solids as a part of the total sample.

From the analyses it is apparent that the major chemical constituents of the well effluent exist as chlorides and based on analysis of sample S-29 the proportions are as follows:

NaCl - 20%
KCl - 5%
CaCl₂ - 10%

Based on a maximum total mass flow of 630,000 lbs./hr. of well effluent, the following approximate quantities of these salts may be realized:

NaCl - 128,000 lbs./hr = 1,540 tons/day
KCl - 31,200 lbs./hr = 370 tons/day
CaCl₂ - 63,500 lbs./hr = 760 tons/day

Should the above chemical relationships obtain when well flow has become stabilized, the chemical production of this well will be a major factor to consider in its ultimate development.

Unpublished results of an analysis on non-condensable gases in the steam show the following constituents:

CO₂ - 89.5%
H₂S - 0.35%
O₂ - 1.9 %
CO - TRACE
Hydrocarbon gas - TRACE
Nitrogen - Remainder-Approx. 8%

The non-condensable gases represent approximately .16% of the steam on a volume basis.

In order to evaluate the chemical plant potential of the well, a detailed engineering study and economic analysis will be required to ascertain the chemical process plant characteristics required to obtain maximum practical and economical utilization of the well effluent.

SECTION 5

APPENDIX

TABLE NO. 1

O'NEILL GEOTHERMAL, INC.
IID WELL #1

FLOW TEST DATA.

TAKEN BY ROGERS ENGINEERING CO. INC.
RECO. REF. - 1786-1A

DATE	TIME	VALVE SETTING & READING	STEAM					BRINE					SEPARATOR			WELL-HEAD			
			MANOMETER INCHES HG			PRESS P.S.I.G.	TEMP °F	MANOMETER			PRESS P.S.I.G.	TEMP °F	SPECIFIC GRAVITY	PRESS P.S.I.G.	TEMP °F	WATER LEVEL*	PRESS-PO P.S.I.G.	PRESS-PI P.S.I.G.	TEMP °F
			LEFT	RIGHT	TOTAL			LEFT	RIGHT	TOTAL									
5-29	11.55	1	6.9	6.9	13.8	72	328	.65	.65	1.30	86	324		67	320	2/5 OF T.W.C.	145	151	-
5-29	4.45	2	7.7	7.7	15.4	73	330	.60	.60	1.20	80	334		75	325	2/3 OF T.W.C.	200 ^{3P}	151	384
5-29	5.00	3	5.8	5.8	11.6	97	348	.70	.70	1.40	103	350		100	339	2/3 OF T.W.C.	200	160	388
5-29	5.15	4	3.8	3.8	7.6	133	368	.75	.75	1.50	138	362		135	356	1/2 OF T.W.C.	230	180	398
5-29	5.25	5	2.75	2.75	5.50	158.5	376	.85	.85	1.70	163	368		162	368	5/8 OF T.W.C.	250	198	405
5-30	11.50	6	7.7	7.8	15.50	74-	334	.65	.65	1.30	81-	336		77	325	5/8 OF T.W.C.	190	152	384
5-30	12.00	6A N.C.	7.7	7.8	15.50	73.5	332	.60	.60	1.20	80-	332	+ 1.324	78	325	1/2 OF T.W.C.	190 ^N	152	384
5-30	12.15	7	6.3	6.35	12.65	90-	342	.70	.60	1.30	97-	342		94	335	1/2 OF T.W.C.	197 ^E	158	388
5-30	12.25	7A N.C.	6.3	6.3	12.6	91-	346	.65	.65	1.30	97-	342		94	336	1/3 OF T.W.C.	197 ^T	159	388
5-30	4.05	7B			BLOW		LINE			OPEN							300 ^W	245 ^E	420
5-31	10.05	8	5.90	6.05	11.95	84-	338	.60	.60	1.20	90-	338		89	331	3/4 OF T.W.C.	280 ^{SEE}	225	416
5-31	10.25	8A N.C.	6.0	6.15	12.15	83-	340	.70	.70	1.40	88-	340		88	330	1/2 OF T.W.C.	280	225	415
5-31	10.40	9	5.6	5.75	11.35	81-	334	.65	.65	1.30	90-	334		87	329	7/8 OF T.W.C.	310	255	424
5-31	10.45	9A N.C.	5.55	5.7	11.25	82-	337	.75	.75	1.50	90-	338		87	329	3/4 OF T.W.C.	310	255	426
5-31	11.00	10	5.65	5.8	11.45	80-	340	.65	.65	1.30	89-	338		85	329	1/2 OF T.W.C.	380 ^Y	302	440
5-31	11.50	11	6.35	6.50	12.85	85-	342	.70	.70	1.40	92-	336		92	332	3/4 OF T.W.C.	202	210	409
5-31	12.15	11A N.C.	6.35	6.45	12.80	85-	340	.65	.55	1.20	91-	335		93	332	3/4 OF T.W.C.	202	211	410
5-31	1.05	12	5.8	5.85	11.65	67	330	.50	.45	.95	75	320		75	320	1/2 OF T.W.C.	397	-	462
5-31	2.10	13	3.55	3.6	7.15	58	319			SALTED UP	64	313		64	313	Bot OF T.W.C.	470 [±]	-	480

NOTE 1: UNRELIABLE PRESSURE GAGE

+ — SPECIFIC GRAVITY @ 80°F ±
N.C.—NO CHANGE IN VALVE SETTING
* T.W.C. — TOP WATER COLUMN

TABLE NO. 2
FLOW TEST RESULTS
I.I.D. WELL #1

Valve Setting & Reading	Flow Rate - lbs/hr.			Flash Tank Press - psig	Well Head	
	Steam	Brine	Total		Press - psig	Temp °F
11	123,000	473,000	596,000	77	151	-
2	130,000	455,000	585,000	75	151	384
3	126,000	492,000	618,000	100	160	388
4	117,000	510,000	627,000	135	180	398
5	106,000	542,000	648,000	162	198	405
6	131,000	473,000	604,000	77	152	384
6A	131,000	455,000	586,000	78	152	384
7	128,000	473,000	601,000	94	158	388
7A	128,000	473,000	601,000	94	159	388
8	121,000	455,000	576,000	89	225	416
8A	121,000	492,000	613,000	88	225	415
9	116,000	473,000	589,000	87	255	424
9A	116,000	510,000	626,000	87	255	426
10	116,000	473,000	589,000	85	302	440
11	125,000	492,000	617,000	92	210	409
11A	125,000	455,000	480,000	93	211	410
12	108,000	405,000	513,000	75	397	462
13	80,000	-	-	64	470	480

CURVE NO. 1

WELL PERFORMANCE CURVES
L.I.D. WELL NO. 1

BRAWLEY CALIFORNIA AREA

ONEIL GEOTHERMAL INC.

MIDLAND TEXAS

JUNE 1962

TOTAL FLOW

LIQUID

FLASH TANK

A ①
TOTAL FLOW

WELL

FLOW TEST DIAGRAM

③ C
STEAM

③ B
LIQUID

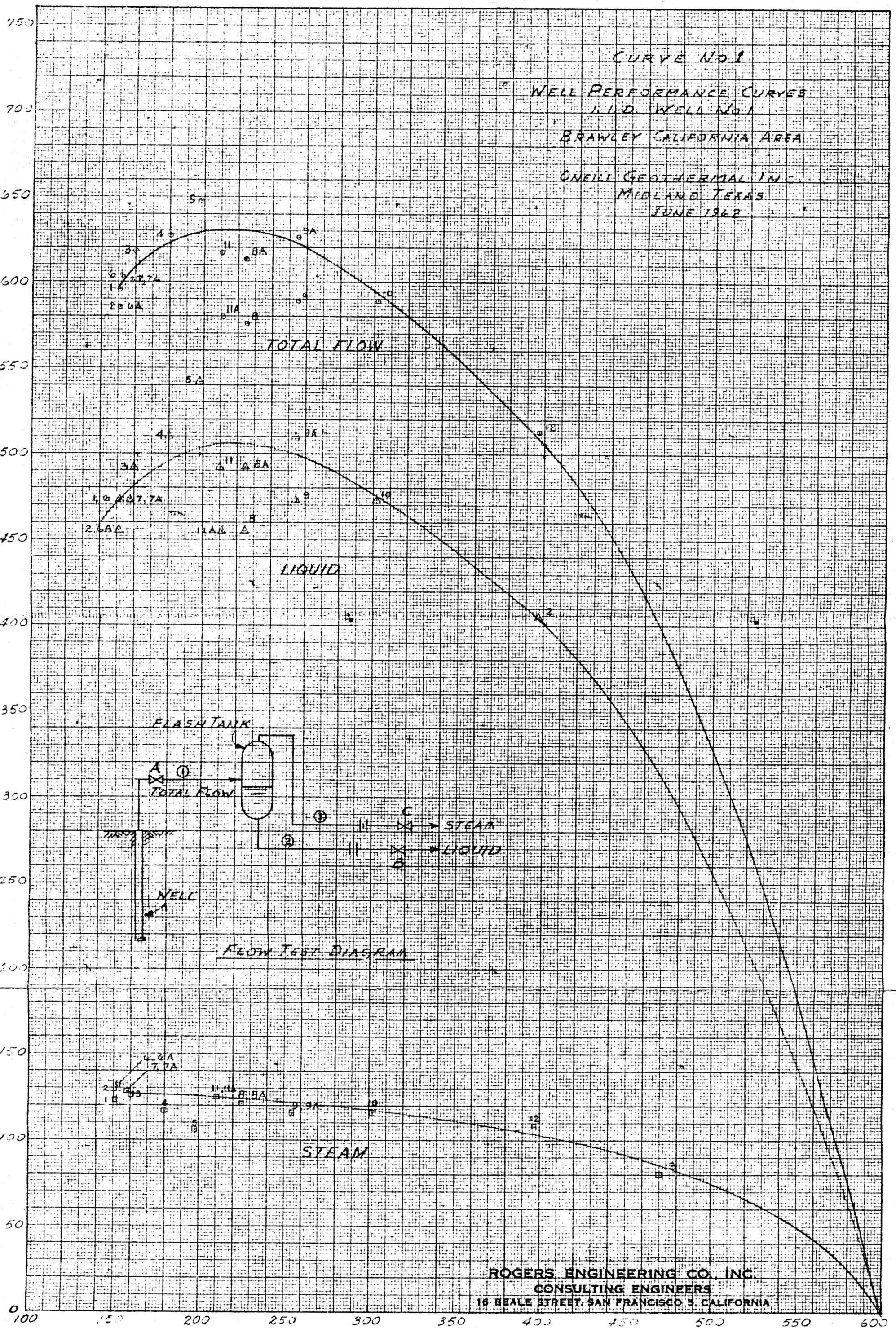
STEAM

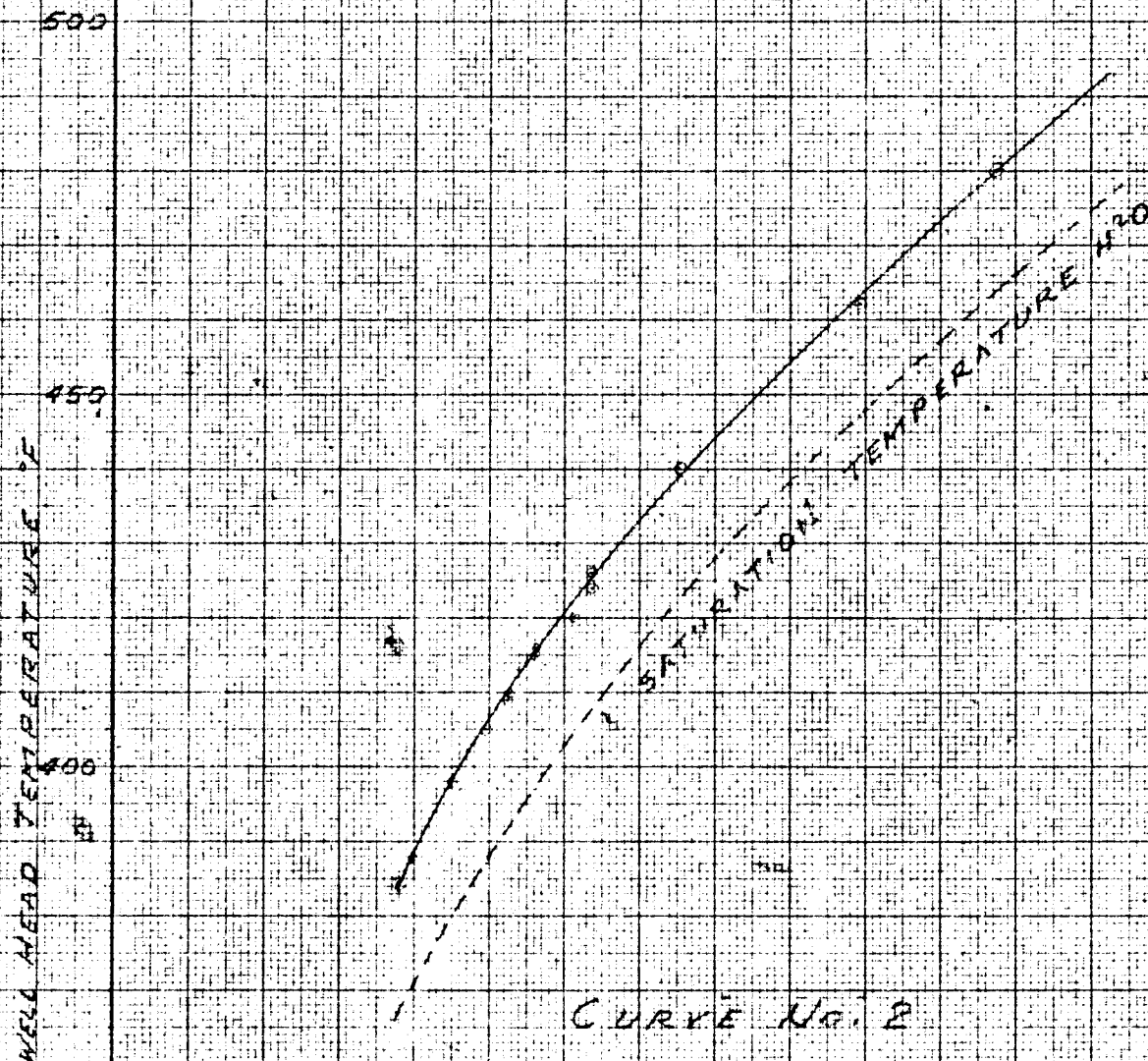
ROGERS ENGINEERING CO., INC.
CONSULTING ENGINEERS

18 BEALE STREET, SAN FRANCISCO 3, CALIFORNIA

WELL HEAD PRESSURE (PSI)

MASS FLOW RATE (LBS/HOUR)





WELL HEAD PRESSURE-TEMPERATURE CURVE
(METERED FLOW)

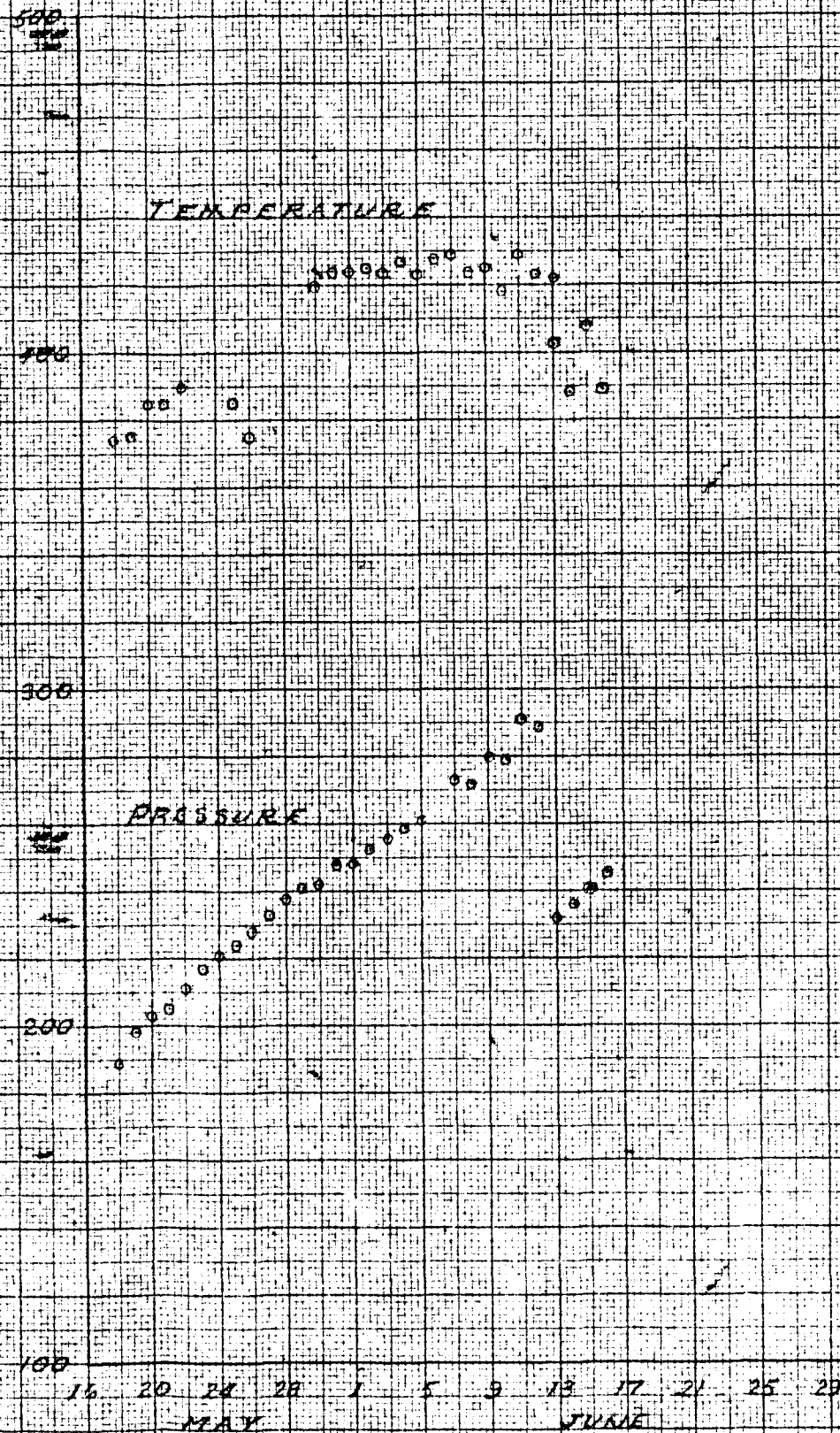
W.D. WELL NO. 1
BRANLEY CALIFORNIA AREA

ONEILL GEOTHERMAL INC.
MIDLAND TEXAS
JUNE 1962

ROGERS ENGINEERING CO., INC.
CONSULTING ENGINEERS
16 BEALE STREET, SAN FRANCISCO 3, CALIFORNIA

WELL HEAD

TEMPERATURE °F
PRESSURE PSIG



CURVE NO. 3

DAILY
WELL HEAD PRESSURE & TEMPERATURE CURVES
(BY-PASS FLOW)

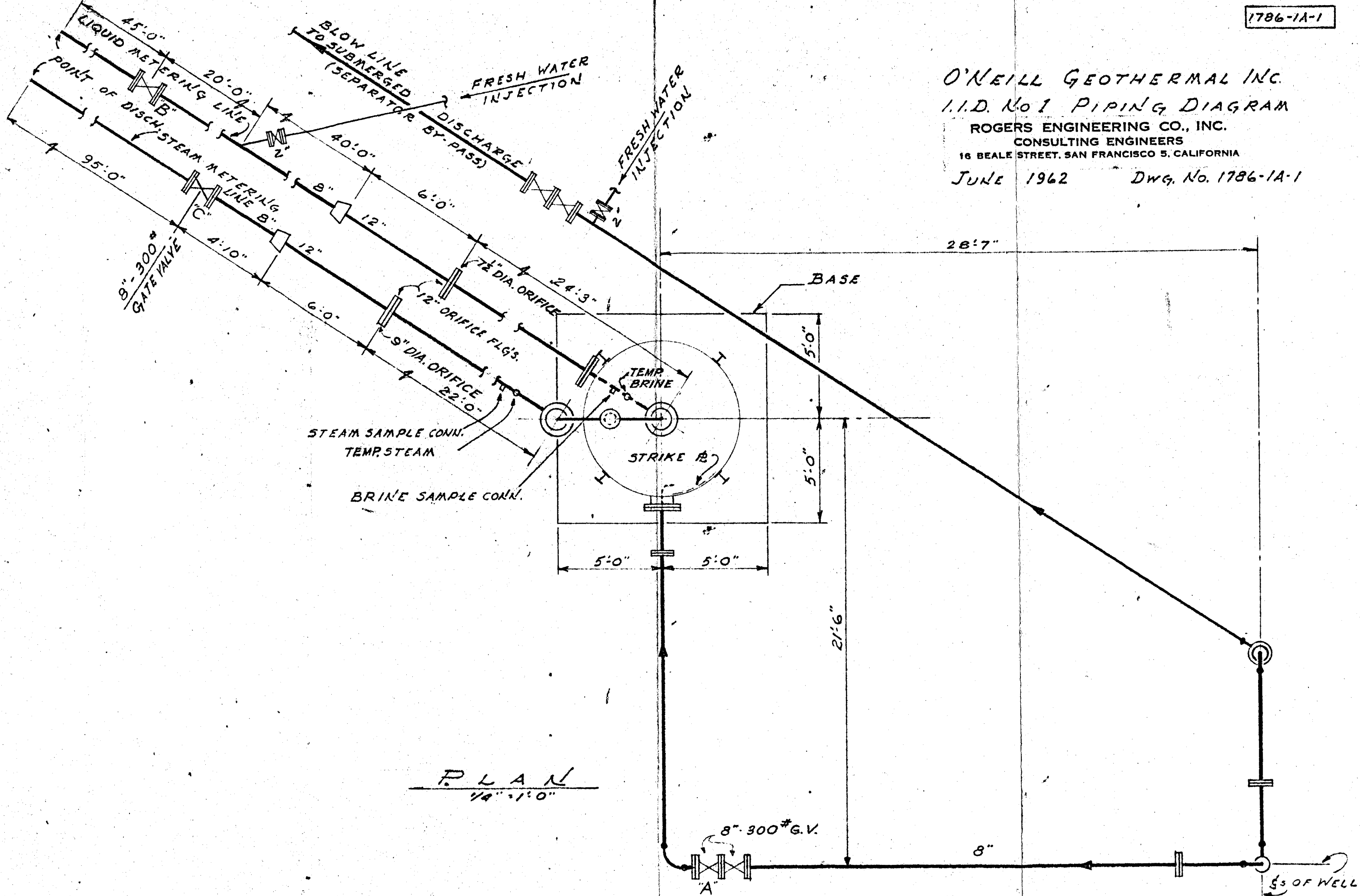
J.T.D. WELL NO. 1.
BRANLEY, CALIFORNIA, AREA

OWELL GEOTHERMAL INC.
MIDLAND, TEXAS
JUNE 1962

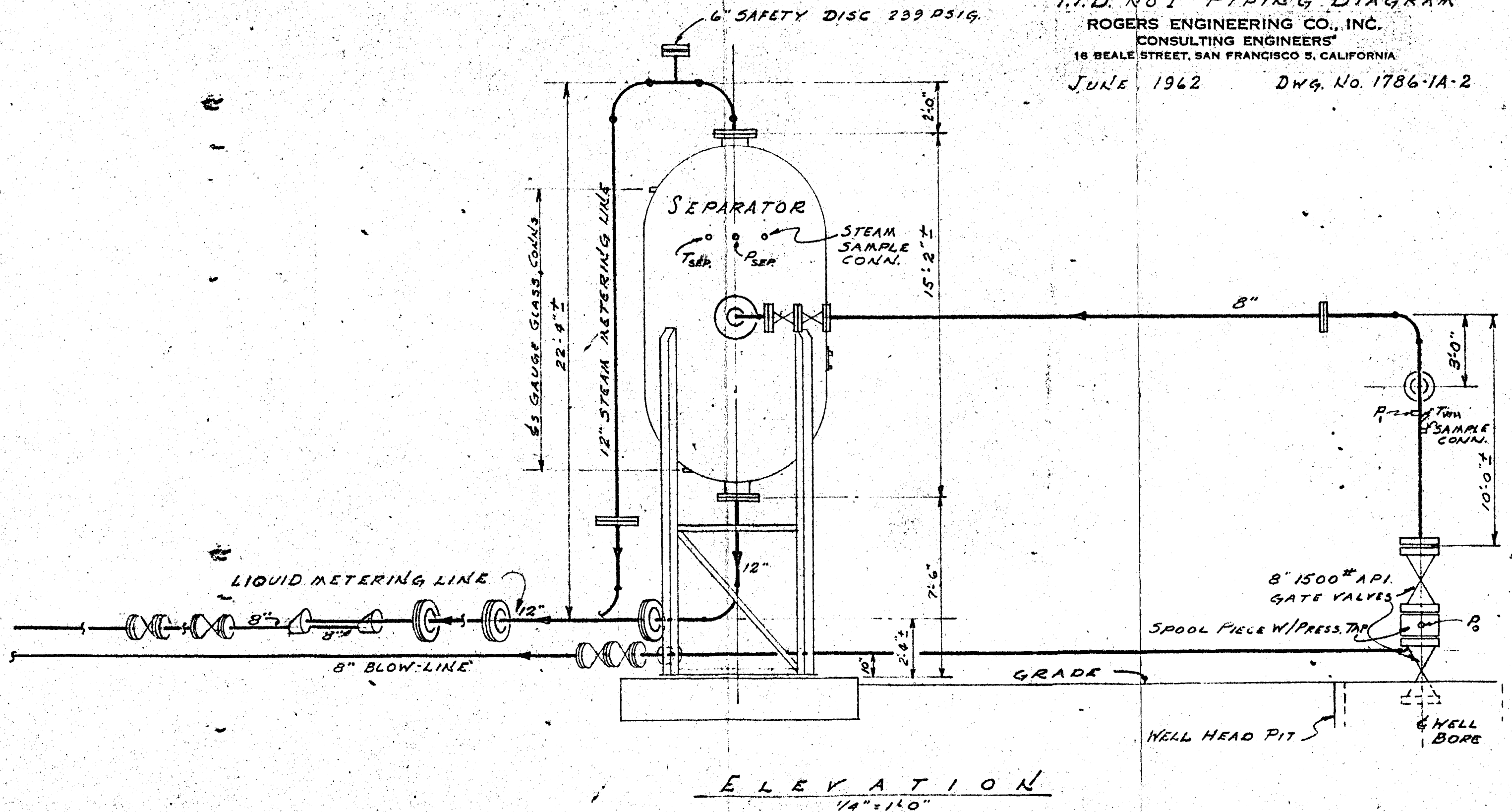
ROGERS ENGINEERING CO., INC.
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O'NEILL GEOTHERMAL INC.
I.I.D. No 1 PIPING DIAGRAM
ROGERS ENGINEERING CO., INC.
CONSULTING ENGINEERS
16 BEALE STREET, SAN FRANCISCO 5, CALIFORNIA

JUNE 1962 DWG. No. 1786-1A-1



O'NEILL GEOTHERMAL INC.
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PHOENIX TESTING LABORATORIES

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AMERICAN INSTITUTE MINING, METALLURGICAL
AND PETROLEUM ENGINEERSO'Neill Geothermal, Inc.
Laboratory No. 152
June 6, 1962SPECTROGRAPHIC TESTS ON BRINE EVAPORATION SALTSPERCENTAGES

Sample Mark	<u>S-20</u>	<u>S-22</u>	<u>S-25</u>
Boron	.07	.07	.2
Silicon	.005	.005	.005
Manganese	.2	.2	.2
Magnesium	.02	.005	.009
Lead	-	-	.2
Iron	.6	.4	.6
Copper	.009	.003	.005
Titanium	.003	.001	.003
Lithium	.1	-	.1
Potassium	.5	.5	.5
Strontium	.04	.02	.09
Sodium	Major constituent for all three samples		
Calcium	Intermediate constituent for all three samples.		

Salts are very hygroscopic - extremely difficult to dry.

Tests made on dissolved solids only. Considerable iron precipitate noticed in bottom of container.

RECEIVED
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cc: (4) O'Neill Geothermal, Inc.

RESPECTFULLY SUBMITTED.

PHOENIX TESTING LABORATORIES

BY

John D. Hess, President

CHEMISTS
ENGINEERS
GEOLOGISTS

John D. Hess Testing Corporation
EL CENTRO, CALIFORNIA

AGRICULTURE
HYDROLOGY
MINING
ENGINEERING MATERIALS

TO: O'Neill Geothermal Inc.
410 W Ohio
Midland, Texas
LAB. NO 152
DATE 6-4-62

PRINCIPALS ARE MEMBERS OF
AMERICAN SOCIETY OF CIVIL ENGINEERS
AMERICAN SOCIETY FOR TESTING MATERIALS
AMERICAN CHEMICAL SOCIETY
AMERICAN CONCRETE INSTITUTE
AMERICAN GEOPHYSICAL UNION
AMERICAN INSTITUTE MINING, METALLURGICAL
AND PETROLEUM ENGINEERS

ANALYSIS OF WELL BRINE

	Well 9:30 A.M. I.I.D. #1 S-20 5-18-62	I.I.D. #1 S-22 5-22-62	I.I.D. #1 S-25 - 5-22-62 10:00 A.M.
Calcium - Ca			
Magnesium -Mg			
Sodium - Na	40,000	52,000	80,000
Potassium - K	11,000	15,625	28,000
Bicarbonate - HCO_3	195	488	488
Carbonate - CO_3	0	0	0
Sulfate - SO_4	2,400	4,500	5,000
Chloride - Cl	104,000	136,000	221,000
Total Soluble Salts	251,200	310,000	548,000
pH	5.2	5.15	5.22
Total Iron Dissolved	1,200	1,500	3,000
Total Hardness CaCO_3 , P.p.m.	64,800	88,000	110,000

The above values are approximate since a 10,000:1 dilution was necessary for determinations

Please note: The water submitted is brine and not routine water. It appears that considerable carbon dioxide and other gases are dissolved in the water. As the temperature is reduced the gases escape, converting ferrous iron to ferric iron. The salts are so high that the water cannot be analyzed by conventional methods. You may expect a considerable variation in analyses on the same sample depending upon delay in analyses and rate of oxidation.

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JUN 12 1962

Rogers Engineering Co., Inc.
SAN FRANCISCO

cc: (2) O'Neill Geothermal, Inc.
(4) Robert Lingquist

RESPECTFULLY SUBMITTED.

John D. Hess Testing Corporation

BY

JOHN D. HESS, GEOLOGIST

TO: O'Neill Geothermal Corporation
Midland, Texas

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AND PETROLEUM ENGINEERS

LAB. NO.: 164
DATE: 6-12-62

SPECTROGRAPHIC ANALYSIS OF WATER PRECIPITATE

Mark	S-29 5-30-62 9:45 A.M. (A)	Steam Meter Run 5-31-62 11:30 A.M. (B)	S-33 6-4-62 9:00 A.M. (C)	Solid Chunk of Solid No Mark (D)
Boron	0.1	0.5	0.08	0.01
Silicon	0.02	Intermediate	1.0	0.1
Aluminum	Nil	1.0	Nil	0.01
Silver	Nil	0.01	Nil	Nil
Manganese	0.1	0.5	0.2	0.1
Magnesium	0.07	0.1	0.07	0.05
Strontium	0.02	Nil	0.03	Nil
Lead	0.05	2.0	Nil	0.3
Chromium	Nil	0.3	Nil	Nil
Copper	0.1	Intermediate	0.1	0.1
Iron	0.5	Major	1.0	0.1
Barium	0.8	Nil	1.0	Nil
Calcium	7.0	4.0	8.0	4.0
Lithium	Nil	0.5	Nil	Nil
Sodium	Major	1.0	Major	Major
Zinc	Nil	Major	Nil	Nil

Samples of A, B, C represent tests on solids which settled out of "as received" solution after standing 4 days.

Sample D tests made on salt cake submitted by client.

Results reported as approximate percent. Major constituent = 10%+, Intermediate Constituent = 1-10%

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SAN FRANCISCO

John D. Hess Testing Corporation

BY

JOHN D. HESS, GEOLOGIST

CHEMISTS
ENGINEERS
GEOLOGISTS

John D. Hess Testing Corporation
EL CENTRO, CALIFORNIA

AGRICULTURE
HYDROLOGY
MINING
ENGINEERING MATERIALS

TO: O'Neill Geothermal Corporation

LAB. NO.: 164
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SPECTROGRAPHIC ANALYSIS OF WATER EVAPORATION SALTS

	S-29 5-30-62 9:45 A.M.	Steam Meter Run 5-31-62 11:30 A.M.	Steam Separator 6-1-62 12:00 Noon	Salton Sea Discharge 6-5-62 12:15 P.M.	S-33 6-4-62 9:00 A.M.
	(1)	(2)	(3)	(4)	(5)
Boron	0.1	0.09	0.1	0.04	0.1
Silicon	Nil	Nil	0.2	0.1	Nil
Aluminum	Nil	Nil	0.05	Nil	Nil
Silver	Nil	Nil	Nil	Nil	Nil
Manganese	0.3	0.3	0.2	0.3	0.3
Nickel	Nil	Nil	Nil	Nil	Nil
Magnesium	0.1	0.1	0.5	0.5	0.1
Strontium	0.04	Nil	0.05	0.05	0.03
Lead	1.0	Nil	Nil	Nil	0.5
Chromium	Nil	Nil	Nil	Nil	Nil
Copper	0.02	0.002	0.004	0.002	0.003
Iron	0.6	0.5	0.2	0.3	0.5
Barium	Nil	Nil	Nil	Nil	Nil
Calcium	Intermediate constituent		All Samples.....		
Lithium	Nil	Nil	Nil	Nil	Nil
Sodium	Major constituent - all samples				
Zinc	Nil	Nil	Nil	Nil	Nil
Potassium	1.0	0.5	Nil	Nil	0.5

Samples Nos. 1, 2, 4, 5: Iron precipitated after original "as received" suspension-solution filtered and clear solution evaporated for above tests

Major constituent = 10%+ Intermediate constituent = 1-10% Nil = Slight trace or none found

cc: (2) O'Neill Geothermal, Inc.
(2) Rogers Engineering Co, S. F.
(2) Mr. Robert Lénquist

RESPECTFULLY SUBMITTED.

John D. Hess Testing Corporation
Rogers Engineering Co., Inc.
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WATER ANALYSES ON FILTERED SAMPLES

	SALTS-SOLUBLE				
	1	2	3	4	5
Specific Electrical Conductance, $K \times 10^{-6}$ @ 25°C.	234,741	107,527	2242	37,037	234,741
Specific Gravity @ 78°F.	1.250	1.058	N.D.	N.D.	1.252
Qualitative for Iron	Filtered Heavy	Med.	None	Slight	Heavy
Sulfate	363	149	33	690	503
Total Soluble Salts By Evaporation	449,800	98,700	492	29,160	447,600
Chloride	201,600	47,950	241	13,630	218,700
Carbonate	None	None	None	None	None
Bicarbonate	248	372	771	49	490
Sodium	80,000	15,000	125	5,200	80,000
Potassium	26,000	5,500	31	1,690	25,000
Nitrate	+	+	0	+	+
Phosphate	0	0	+	0	0
Calcium	36,800	7,800	46	2,240	36,000
Magnesium	2,200	120	Ni	220	1,900

Results reported in parts per million
Iron settles out of No. 4 readily

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